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SAMPLE PREPARATION AND COUNTING OF RADIOISOTOPES BY LIQUID SCINTILLATION COUNTING  
AND THEIR APPLICATION TO SOIL, SOIL/PLANT AND PLANT STUDIES: A BIBLIOGRAPHY

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### Foreword

This bibliography is a collection of references that I have accumulated over the past five years. It is not claimed to be a complete bibliography on the subjects covered but merely to be a selection of references to give an introduction to the individual fields of research. This bibliography will be added to in the future.



## LIQUID SCINTILLATION COUNTING

1. General references

- Bell, C. G. and Hayes, F. N. (1958). Liquid Scintillation Counting. Pergamon Press Oxford.
- Birks, J. B. (1971). An introduction to liquid scintillation counting. Koch Ligh Laboratories handbook.
- Birks, J. B. (1964). The theory and practice of liquid scintillation counting. Pergamon Press Oxford.
- Crook, M. A. and Johnson, P. (1974). Liquid scintillation counting. Vol. 3. Heyden and Sons 310 pp.
- Dyer, A. (1974). An introduction to Liquid Scintillation counting. Heyden and Sons. 111 pp.
- Price, L. W. (1973). Protical course in liquid scintillation counting. Pt 1 Principles and Chemistry. Lab. Practice 22 (1): 27.
- Price, L. W. (1973). Practical course in liquid scintillation counting. Pt VIII Hazard and safety aspects of liquid scintillation counting. Lab. practice 22 (9): 571.
- Rapkin, E. (1974). Liquid scintillation counting 1957-63: A review. Int. J. Appl. Rad. Isotopes 15(2): 69-87.
- Venverloo, L. A. J. (1971). Practical Measuring Techniques for Beta Radiation. Macmillan, London. pp 154.

2. Preparation and counting of samples

- Allison, J. M., Monro A. M., Offerman, J. L. (1972). Potential errors in liquid scintillation counting of very dilute solutions of labelled tetracyclines. Anal. Biochem. 47(1): 73-79.
- Apelgot, S., Chemama, R., Frilley, M. (1971). A technique for the direct counting of  $^{14}\text{C}$  or  $^3\text{H}$  in biological fluids. Monatsch. Chem. 102(4) 985-1005.
- Ayad, M. (1972). Liquid scintillation methodology. Lab. Practice 21(10): 723.
- Awerbuch, T. and Avnimelech, Y. Counting of  $\text{P}^{32}$  in plant tissues using Cerenkov effect. Pl. and Soil 33, 260-64.
- Barakat, M. F. and Zahran, A. H. (1969). Radioacting assay of sulphur-35 in labelled organic compounds. Int. J. Appl. Rad. and Isotopes 20(2): 109.
- Bell, T. K. (1970). Liquid scintillation counting using external standard and channels ratio techniques for quench correction. Lab. Practice 17:809.
- Benakis, A. (1971). A new Gelifying Agent in liquid scintillation counting. In "Liquid Scintillation Counting". Vol. 1. Proc. Symp. Univ. Salford. Sept. 1970. p. 97. Heyden and Sons.
- Birks, J. B. (1971). Liquid Scintillator Solvents. In "Organic scintillators and Liquid scintillation counting". Ed-Horrocks, D. L. and Chin - Tzu - Peng. Acad. Press 1971.

- Birks, J. B. and Poullis, G. C. (1972). Liquid scintillators. In "Liquid scintillation counting Vol. 2" pp 1-21. Eds: Crook, Johnson and Scales. Heyden and Sons Limited.
- Bohne, F. Difficulties in measuring the tritium activity of tissue homogenates by the new scintillator insta-gel. Int. J. Appl. Radiat. Isotope 22(6): 384.
- Bransome, E. D. and Grower, M. F. (1970). Liquid scintillation counting of  $H^3$  and  $C^{14}$  on solid supports: A warning. Anal. Biochem. 38(2) 401-408.
- Brown, L. C. (1971). Determination of Phosphorus-32 and 33 in Aqueous Solution. Anal. Chem. 43(10): 1326-8.
- Caddock, B. D. et al. A new procedure for determining the counting efficiency - Liquid scintillation counting. Int. J. Appl. Rad. Isotope. 18(4): 209-214.
- Campbell, C. B. and Powell, L. W. (1970). Use of Triton X-100 scintillant in a simple method for the simultaneous assay of  $^{55}Fe$  and  $^{59}Fe$  by liquid scintillation counting. J. Chim. Pathol. (Lond) 23(4): 304-308.
- Carney, G. C. (1972). The estimation of small quantities of carbon-14 labelled adenine nucleotides following their separation by ion exchange paper chromatography. In "Liquid scintillation counting Vol. 2" p 213-215 Eds: Crook, Johnson and Scales. Heyden and Sons Limited.
- Carter, G. W. and Van Dyke, K. A. A superior counting solution for water-soluble tritiated compounds. Clin. Chem. 17(7): 576-80.
- Cember, H. (1968). Application of analysis of variance to test for counter stability. Health physics. (nov. edn.) p 471.
- Chakravarti, A. and Thanassi, J. W. (1971). Liquid scintillation counting of  $C^{14}$  and  $H^3$  samples on filter paper. Anal. Biochem. 40(2): 484-487.
- Chapman, D. I. and Mancroft, J. The use of Triton X-100 in the liquid scintillation counting of carbon-14 with particular reference to plasma and urine. Int. J. Appl. Rad. Isotope. 22(6): 371-77.
- Cheshire, M. V., Shepherd, H., Knight, A. H. and Mundie, C. M. (1972). Determination of  $^{14}C$  in soil by a gel suspension method. J. Soil Sci. Vol. 23(4): 420-423.
- Chojnacki, T., and Matysiak, Z. (1971). Direct counting of nucleotide  $^{32}P$  absorbed on charcoal using a scintillation spectrometer. Anal. Biochem. 44(1): 297-299.
- Curtis, E. J. C. and Toms, I. P. (1972). Techniques for counting carbon-14 and phosphorus-32 labelled samples of polluted natural waters. In "Liquid scintillation counting Vol 2". p 167-180. Eds: Crook, Johnson and Scales. Heyden and Sons Limited.
- Davison, P. F. and Anderson, L. P. (1972). Scintillation counting: Absorption and solvation problems. Anal. Biochem. 47(1) 253-263.
- Dyer, A. (1972). Methods of sample preparation of Inorganic material including cerenkov counting. In "Liquid scintillation counting Vol. 2". p 121-137. Eds: Crook, Johnson and Scales. Heyden and Sons Limited.
- Elsmere, G. T. (1972). Polythene vials for scintillation counting. Rothamsted Expt Stn Ann. Rept. 1972 p 64.

- Fillet, G. (1972). Use of Triton X-100 for high efficiency liquid scintillation counting of plasma Fe<sup>59</sup>. *Pathol. Biol.* 20 (5/6) 227-230.
- Flynn, K. F., Glendenin, L. E. and Prodi, V. (1971). Absolute counting of low energy Beta emitters using liquid scintillation counting techniques. In "Organic Scintillators and Liquid Scintillation Counting". p 687. Ed. Horrocks, D. L. and Chin - Tzu - Peng. Acad. Press 1971.
- Fox, B. W. Sample preparation techniques for scintillation counting. *Lab. Practice* 17 (5): 595.
- Friedman, M. A., Millar, G., McEvoy, A. and Epstein, S. S. (1971). Rapid and simplified method for liquid scintillation counting of radioactive proteins using Aqua sol. *Anal. Chem.* 43(6): 780-781.
- Fuchs, A. and De Vries, F. W. (1972). A comparison of methods for the preparation of <sup>14</sup>C-labelled plant tissues for liquid scintillation counting. *Int. J. Appl. Radiat. Isotope* 23(8): 361-369.
- Gibson, J. A. B. and Lally, A. E. (1971). Liquid scintillation counting as an analytical Tool. *The Analyst* 96(1147): 681-88.
- Grundon, N. J. and Asher, C. J. (1972). Improved method for determination of sulphur-35 in plant material using oxygen flask combustion and liquid scintillation counting. *J. Agric. Food Chem* 20(4): 794-798.
- Gupta, G. N. (1968). A new procedure for liquid scintillation counting in plastic bags for <sup>3</sup>H, <sup>14</sup>C and <sup>32</sup>P in biological materials. In "Isotopes and Radiation in Soil organic matter studies". Proc. Synop. Vienna 15-19 July 1968. p 31-38. I.A.E.A. Vienna 1968.
- ten Haaf, F. E. L. (1972). Colour quenching in liquid scintillation coincidence counters. In "Liquid scintillation counting Vol 2." p 39-48. Eds: Crook, Johnson and Scales. Heyden and Sons Limited.
- Haasbrock, F. J., De Villiers, J. F., Deist, J. and Rousseau, P. C. (1971). Measurement of <sup>32</sup>P in wet-ashed plant samples using Cerenkov radiation. *Agrochimophysica.* 3(2): 27-31.
- Hardcastle, J. E., Fuller, W. H. and Hannapel, R. J. (1972). Simultaneous assay of calcium-45 and Strontium-89 in double-isotope biological samples by liquid scintillation counting. *Anal. Biochem.* 46(2): 534-547.
- Haviland, R. T. and Bieber, L. L. (1970). Scintillation counting of P<sup>32</sup> without added scintillation in aqueous solutions and organic solvents and on dry chromatographic media. *Anal. Biochem.* 33; 323-34.
- Haydon, A. H., Davis, W. B., Arceneaux, J. L., Gentry, G. A. and Byers, B. R. (1972). Simplified method for liquid scintillation counting of <sup>55</sup>Fe using secondary hydroxamic acids as chelating agents. *Biochim. Biophys. Acta* 273(1): 1-4.
- Helling-Larsen, P. (1971). Liquid scintillation counting of <sup>3</sup>H and <sup>32</sup>P-RNA in slices of polyacrylamide Gel. *Anal. Biochem.* 39(2): 454-61.
- Helweg, A., and Sorenson, L. H. (1973). Scintillation counting of <sup>14</sup>C-activity in soil suspended in Cab-O-sil gel. *Soil Biol. Biochem.* 5(6): 903-906.
- Horrocks, D. L. and Peng, Chin-Tzu. (1971). Organic Scintillators and Liquid Scintillation counting. Acad. Press. 1971.
- Horrocks, D. L. (1968). Direct measurement of <sup>14</sup>-CO<sub>2</sub> in liquid scintillation counter. *Int. J. Appl. Rad. Isotopes.* 19(12): 859.

- Houminer, Y. and Weirstein, M. (1968). A simple technique for collecting  $Cl^{14}$ - $CO_2$  under reduced pressure for liquid scintillation counting. *Int J. Rad. Appl. and Isotopes*. 19(8): 663-4.
- Kalben, D. A. (1971). Chemiluminescence as a problem and an analytical tool in Liquid Scintillation counting. In "Liquid Scintillation Counting Vol 1". Proc. Symp. Univ. Salford. Sept 21-22 1970 p 1. Ed. Dyer, A. Heyden and Sons Limited.
- Kalphen, D. A. (1972). Comparison of the energy spectra of chemiluminescence, phosphorescence, carbon-14 and tritium, recorded with a liquid scintillation spectrometer. *Kerntechnik* 14(6): 272-275.
- Kornblatt, J. A., Bernath, P. and Katz, J. (1964). The determination of specific activity of  $Ba\ C^{14}O_3$  by liquid scintillation assay. *Int. J. Appl. Rad. Isotopes* 15(4): 191-194.
- Krichevsky, M. I. and McLean, C. J. (1971). Optimism techniques for Computer Aided Quench Correction. In "Liquid Scintillation Counting, Vol. 1". Proc. Symp. Univ. Salford. p 55-67 Heyden and Sons Limited.
- Kumar, I. and Berger, E. Y. (1968). Preparation of samples for liquid scintillation analysis of tritiated water in biological material. *Int. J. Appl. Rad. Isotopes* p 805.
- Kuyper, A. C. and Aghdashi, M. (1972). Determination of carbonate- $C^{14}$ . by liquid scintillation counting. *Anal. Biochem.* 45(1): 341-343.
- Langenscheidt, E. (1971). Emission Spectra of liquid organic scintillators. In "Liquid scintillation counting. Vol. 1". Proc. Symp. Univ. Salford. Sept. 1970 p 23 Heyden.
- Läuchli, A (1969). Radioassay for B-emitters in biological materials using Cerenkov Radiation. *Int. J. Appl. Rad. Isotopes*. 20(4): 265-270.
- Leon, S. A. and Bohrer, A. T. (1971). Rapid processing and counting technique for radioactive materials in polyacrylamide gels. *Anal. Biochem.* 42(1) 54-58.
- Lindsay, P. A. and Kurnick, N. B. (1969). Preparation of tissues for liquid scintillation radioactivity counting. *Int. J. Appl. Rad. Isotopes*. 20(2): 97.
- Lowenthal, G. C. (1969). Secondary standard instruments for the activity measurement of pure B-emitters. A review. *Int. J. Appl. Rad. and Isotopes* 20(8): 559.
- McDowell, R. E. and Copeland, J. C. (1971). Evaluation of different scintillation cocktails for counting of titrated ribonucleic acid, separated by sucrose density centrifugation. *Anal. Biochem.* 41(2): 338-43.
- Meuller, E. B. (1973). Quench correction techniques. Standardization in liquid scintillation counting. In: "Liquid scintillation counting" Vol. 4. Ed. Crook, M. A. and Johnson, P. Heyden.
- Moir, A. T. B. (1971). Channels ratio quench correction using Cerenkov radiation for the assay of  $^{42}K$  in Biological samples. *Int. J. Appl. Rad. Isotopes*. 22(3): 213-216.
- Nagvi, S. M. (1971). Comparison of scintillants for determination of radioactivity in agar gel by liquid scintillation techniques. *Nucleus* (Karachi) 8(3): 109-112.



- Noujam, A., Ediss, C. and Wiebe, L. Precision of some quench correction methods in liquid scintillation counting. In "Organic scintillators and liquid scintillation counting". p 705 Ed. Horrocks, D. L. and Chin-Tzu-Peng. Acad. Press, 1971.
- Painter, K. (1973). Choice of counting vial for liquid scintillation counting: A review In "Liquid scintillation counting" vol. 3. Ed. Crock, M. A. and Johnson, P., Heyden.
- Parker, R. P. (1970). Cerenkov counting. Intertechnique Techn. Review.
- Paus, P. N. (1970). Liquid scintillation counting of RNA: A simple procedure for extraction from sucrose gradients. Anal. Biochem. 38(2): 364-373.
- Pfeffer, M., Weinstein, S., Gaylord, J. and Indindoli, L. (1971). Rapid procedure for liquid scintillation counting of animal tissues using a nitric acid digestion procedure and a dioxan-based scintillator. Anal. Biochem. 39(1): 46-53.
- Piltingsrud, H. V. and Stencel, J. R. (1972). Determination of  $^{90}\text{Y}$ ,  $^{89}\text{Sr}$ , in samples by use of liquid scintillation beta spectroscopy. Health Phys. 23(1): 121-122.
- Plesums, J. and Bunch, W. H. (1971). Measurement of phosphorus following  $^{32}\text{P}$  Cerekov counting. Anal. Biochem. 42(2): 360-362.
- Price, L. W. (1972). Practical course in liquid scintillation counting. Pt 11 Preparation of samples -1. Lab. practice 22(2): 110.
- Price, L. W. (1973). Practical course in liquid scintillation counting. Pt 111 Preparation of samples -2. Lab. Practice 22(3): 181.
- Rapkin, E. Preparation of samples for liquid scintillation by combustion. Technical Bulletin, Intertechnique.
- Rapkin, E. Preparation of samples for liquid scintillation counting. Technical Bulletin. NEN Chemicals GmbH. Frankfurt.
- Rapkin, E. Gel and Emulsion counting of aqueous solutions. Technical Review. Intertechnique.
- Rapkin, E. (1968). Temperature control in Liquid scintillation counting. Intertechnique Tech. Review.
- Rapkin, E. (1969). Sample preparation for liquid scintillation. I. Solubilization techniques. Intertechnique Tech. Review.
- Rapkin, E. (1970). Sample preparation for liquid scintillation counting. II. Solvents and scintillators. Intertechnique Tech. Review.
- Roberts, W. A. (1972). Improved methods for the preparation of liquid scintillation samples. Lab. practice 21(12): 873.
- Ross, H. H. (1971). Performance Parameters of selected waveshifting compounds for Cerenkov counting. In "Organic scintillators and liquid scintillation counting". Ed. Horrocks, D. L. and Chin-Tzu-Peng. p 757 Acad. Press.
- Scales, B. (1963). Liquid scintillation counting: the determination of background counts of samples containing quenching substances. Anal. Biochem. 5(6): 489-496.

- Schneider, P. B. (1971). Determination of specific activity of  $^{32}\text{P}$  labelled compounds using Cerenkov counting. *J. Nucl. Med.* 12(1): 14-16.
- Schone, M. G. T., Mercer, E. R., Wood, A. V. and Hill, D. (1972). Preparation of plant material for liquid scintillation counting. Letcombe Laboratory Ann. Rept. 1972. p 39-40.
- Seidel, A. and Volf, V. (1972). Rapid determination of some transuranium elements in biological material by liquid scintillation counting. *Int. J. Appl. Rad. Isotopes.* 23(1): 1-4.
- Shamoo, A. E. (1971). An improved toluene base scintillator for estimating radioactivity in aqueous samples. *Anal. Biochem.* 39(2): 311-18.
- Sibatani, A. (1970). Precipitation and counting of minute quantities of labelled nucleic acids as cetyltrimethyl ammonium salt. *Anal. Biochem.* 33(2): 279-285. *Bio. Abstr.* 51(19): 105500.
- Simpson, E. and Brown, M. C. K. (1973). Scintillation fluids suitable for the counting of isotopes in solutions containing protein. *Clinica Chimica Acta* 45: 135-143.
- Skauen, D. M., Marshall, N., and Fragala, R. J. (1971). A liquid scintillation method for assaying  $^{14}\text{C}$ -labelled benthic microflora. *J. Fish. Res. Bd. Can.* 28(5): 769-770.
- Snipes, M. B. and Lengemann, F. W. (1971). A practical method for resolution of two B-emitting radionuclides by liquid scintillation counting. *Int. J. Appl. Radiat. Isotopes.* 22(9): 513-520.
- Stubbs, R. D. and Jackson, A. (1967). Channels ratio colour quenching correction in Cerenkov counting. *Int. J. Appl. Radiation. Isotopes* 18: 857..
- Teda, A. and Radoszewski, T. (1971). The  $^{47}\text{Tl}$  liquid scintillation method for activity measurement of Electron capture Nuclides. In "Liquid scintillation counting". Vol. 1. Proc. Symp. Univ. Salford September 1970. p 49.
- Tamers, M. A. (1964). Liquid scintillation counting of low level tritium. *Packard Tech. Bull.* 12.
- Tonzetich, J. (1972). Determination of  $^{35}\text{S}$ -labelled compounds of aqueous ionic solutions by liquid scintillation counting. *Anal. Biochem.* 47(2): 584-591.
- Townshend, J. L. (1971). Application of Triton X-100 liquid scintillant to the assay of  $\text{P}^{32}$ ,  $\text{P}^{33}$ , or  $\text{S}^{35}$  in plant digests or soil extracts. *Can. J. Soil Sci.* 51: 308-309.
- Turner, J. C. (1971). Sample preparation for liquid scintillation counting. *Radiochemical Centre Amersham Review.* No. 6.
- Tykva, R. and Votruba, I. (1974). Semi-conductographic determination of labelled substances in thin-layer chromatography. *J. Chromatog.* 93: 399-404.
- Trewavas, A. J. (1967). A new method for counting labelled nucleic acids by liquid scintillation. *Anal. Biochem.* 21: 324-28.
- de Volpi, A. and Forges, K. G. A. (1965). Cerenkov counting of aqueous solutions. *Int. J. Appl. Rad. Isotopes.* 16(8): 496-98.
- Watson, G. R. and Williams, J. P. (1970). Rapid method for Wet Combustion scintillation counting of  $\text{C}^{14}$ -labelled organic materials. *Anal. Biochem.* 33: 356-65.

Webb, R. A. and Mettrick, D. F. (1972). Quantitative liquid scintillation radioassay of phospholipids from thin-layer chromatograms. *J. Chromatog.* 67(1): 75-80.

White, R. P. and Ellis, B. G. (1968). Routine counting of  $^{32}\text{P}$  in coloured solutions from dry ashed plant samples utilising Cerenkov radiation. *Soil Sci. Soc. Amer. Proc.* 32: 740-1.

Wood, K. G. (1970). Effect of the beta spectrum on self-absorption of beta radiation from  $\text{C}^{14}$ . *Int. J. Appl. Rad. and Isotopes.* 21: 581-586.

### 3. Instrumentation

Benthold, F. (1971). A new liquid scintillation counter the BF 5000. *Lab. Equip. digest.* 9(9): 73.

Lloyd-Jones, C. P. and Skerrett, E. J. (1973). Improvements to an automatic counter for radioactive deposits on Planchets. *Anal.* 98: 223-26.

Price, L. W. (1971). Instrumentation for liquid scintillation counting. *Lab Equip. Digest* 9(5): 49-67.

Price, L. W. (1973). Practical course in liquid scintillation counting. Pt VI Choosing and using liquid scintillation counting equipment I. *Lab. Practice* 22(6): 417.

Price, L. W. (1973). Practical course in liquid scintillation counting. Pt IV The practical counter and quench correction. *Lab Practice* 22(4): 277.

### 4. Data Processing

Deterding, J. H. (1972). Experience in off-line computer processing of liquid scintillation counting data. In "Liquid Scintillation counting Vol. 2", p 313-324. Eds: Crook, Johnson, and Scales. Heyden and Son.

Erban, J. (1972). Magnetic tape recording of scintillation scan data using a commercial apparatus. *Radiobiol. Radiother.* 13(1): 55-63.

Glass, D. S. and Woods, T. L. (1971). A comparison of computer Input Methods used to process liquid scintillation counting data. In "Liquid Scintillation Counting". Vol. 1. Proc. Symp. Univ. Salford. Sept. 1970 p 79. Heyden.

Johnson, P., Rising, P. A. and Rising, T. J. ((1972)). Liquid scintillation counting of biological samples using external standardization and automatic data processing. In "Liquid scintillation counting Vol. 2", p 267-277. Eds: Crook, Johnson, and Scales, Heyden and Son.

O'toole, J. J. and Osburn, J. O. (1968). Liquid scintillation analysis - computer processing. *Int. J. Appl. Rad. Isotopes* p 821.

Price, L. W. (1973). Practical course in Liquid scintillation counting. Pt V Computing and Calculating results. *Lab. Practice* 22(5): 352.

Spratt, J. L. (1972). Aquisition and handling of liquid scintillation counting data. In "Liquid scintillation counting Vol. 2", p 245-265 Eds: Crook, Johnson, and Scales, Heyden and Son.

Stanley, P. E. (1972). Determination of absolute radioactivity in multi-labelled samples using external standardization or channels ratio: A Fortran IV program. In "Liquid Scintillation counting Vol. 2", p 285-291 Eds: Crook, Johnson, and Scales, Heyden and Sons.

Thomas, E. (1967). A discussion of statistics and their relation to liquid scintillation counting. Intertechnique Techn. Bull.

Williams, M. A. and Cope, G. H. (1971). The processing of Liquid Scintillation spectrometer data using a Desk-top Computing System. In "Liquid Scintillation Counting, Vol. 1", Proc. Symp. Univ. Salford September 1970 p 69 Heyden and Sons. 1971.

## APPLICATIONS OF RADIO ISOTOPES TO SOIL - SOIL/PLANT - PLANT STUDIES

1. Handling of isotopes

- Bambridge, J. E. and Carter, L. W. (1973). Design and development of a 'mini-tong' for handling small and fragile radioactive specimens. *Lab. Practice* 22(6): 423.
- Barton, G. E. (1965). A grinding technique for small radioactive grass samples. *Lab. practice*. Vol. 15. p 1258.
- Cuppy, D. and Crevasse, L. (1963). An assembly for  $C^{14}O_2$  collection in metabolic studies for liquid scintillation counting. *Anal. Biochem.* 5(5): 462-63.
- Duff, R. B. and Knight, A. H. (1955). A simple apparatus for handling radioactive barium carbonate obtained by wet combustion. *Chem. and Industry* p 1469.
- Farber, T. M. (1964). A simple method for transferring volatile radioactive materials. *Anal. Biochem.* Vol. 9(4): 483-484.
- Jaynes, C. C. (1969). A technique for field use of radioactive phosphorus. *J. Range Management* 22(5): 354-5.
- Loewenstein, H. (1965). An injection Probe for rapid Placement of Radioisotopes. *Soil Sci. Soc. Proc. America.* Vol. 29 p 328.
- Mentzer, C. (1957). A method of administering radioactive solutions to woody plants. *C. R. Acad. Sci. Paris.* Vol. 245 (25): 2354-5
- Yardley, H. J. (1964). A simplified scintillation counting technique for assaying  $^{14}CO_2$  in a Warburg flask. *Nature* 204: 281.
- Young, S. E., Dodd, J. D., Ibert, E. R. Tritium collection and extraction techniques for plant water relationships studies. *Ecology.* 51(3): 535.

2. Soil water studies

- Hazzaa, T. B. Determination of the velocity of ground water flow with radioisotopes. *Int. J. Appl. Rad and Isotopes* 20(2): 127.
- Jennings, A. R. and Schreder, M. C. (1968). Laboratory evaluation of selected radioisotopes as ground water tracers. *Water resources Res.* 4: 829-38.
- Leikola, M. and Paavilainen, E. (1972). Water uptake of pines from frozen soil. In "Isotopes and radiation in soil plants relationships, including forestry". IAEA. p 413.
- Mel'nikova, M. K. and Kovenya, S. V. (1971). Use of Radioactive Tracers for simulating the Lessivage Process. *Soviet Soil Sci.* 3(5) pp 611-618.
- Newbold, P., Mercer, E. R. Lay, P. M. (1968). Estimation of changes in the water status of soils under field conditions from the alteration of B-radiation by water held in absorbed nylon pads. *Expl. Agric.* 4 p 167-177.
- Oleson, S. E. (1973). Gamma radiation for measuring water contents in soil columns with changing density. *J. Soil Sci.* 24(4): 461-469.
- Smith, J. L. (1972). Forest soils and the associated soil-plant water regime. In "Isotopes and Radiation in soil plant relationships, including forestry". IAEA p 399.

Wood, F. M. and O'Neal, D. (1965). Tritiated water as a tool for ecological field studies. *Science* 147, 148-149.

### 3. Plant Root system studies

Atkinson, D. (1974). Some observations on the distributions of root activity in apple trees. *Pl. and Soil* 40(2): 333-342.

Baldwin, J. P., Tinker, P. B. and Marriott, F. H. C. (1971). The Measurement of length and distribution of onion roots in the field and the laboratory. *J. Appl. Ecol.* 8: 543-53.

Bjorkman, E. and Lundeborg, G. (1971). Studies of root competition in a poor pine forest by supply of labelled nitrogen and phosphorus. *Stud. For. Suec.* 94: 3-16.

Boggie, R., Hunter, R. F. and Knight, A. H. (1958). Studies of the root development of plants in the field using radioactive tracers. Pt 1. Communities growing in a Mineral soil. Pt 2. Communities growing in deep peat. *J. Ecol.* 46: 621-639.

Bowen, G. D. and Rovira, A. D. (1971). Relationship between root Morphology and nutrient uptake. In "Recent Advances in plant nutrition". Vol. 1. p 293-303 Ed: Samish, R. M.

Broeshart, H. and Nethsinghe, D. E. (1972). Studies on the pattern of root activity of tree crops using isotope techniques, in "Isotopes and radiation in soil-plant relationships including forestry." IAEA p 453.

Ellis, F. B. and Barnes, B. T. (1973). Estimation of the distribution of plants under field conditions. *Plant and Soil* 39: 81-91.

Gerwitz, A. and Page, E. R. (1973). Estimation of root distribution in soil by labelling with  $R^{60}$  and counting with commercially available equipment. *Lab. Practice.* 22(1): 35-36.

Halm, B. J. et al. (1972). The phosphorus cycle in a nature grassland ecosystem. In "Isotopes and radiation in soil-plant relationships, including forestry." IAEA p 571.

Jacobs, E., Atsman, D. and Kafkafi, U. (1970). A convenient method of placing radioactive substances in soil for studies of root development. *Agr. J.* 62(2): 303-4

Karpov, V. G. (1962). Trials in using  $P^{32}$  to study the competition between the roots. *Dokl. Akad. Nauk SSSR.* Vol 146(3). p 717-9. *For. Abstr.* 24: 3378.

Lipps, R. C. and Fox, R. L. (1964). Root activity of sub-irrigated alfalfa as related to soil moisture, temperature and oxygen supply. *Soil Science* 97: 4-12.

Page, E. R. and Gerwitz, A. (1969). Phosphate uptake by lettuce and carrots from different soil depths in the field. *J. Sci. Ed. Agric.* 20: 85-90.

Pettit, R. D. and Jaynes, C. C. (1971). Use of radiophosphorus and soil-block techniques to measure root development. *J. Range Management* 24(1): 63-65.

Russell, R. S., Clarkson, D. T. and Newbould, P. (1972). Tracer studies of the root systems of crop plants. In "Peaceful uses of Atomic Energy". Proc. 4th U. N. Conf. Geneva, 1971. 12: 215-225.

Scott-Russell, R. (1970). Rootsystems and plant nutrition some new approaches. *Endeavour* 29 (107): 60-66.

Singh, M. M., Pushpaigh, et al (1972). Radiotracer studies on phosphorus uptake by *Hevea brasiliensis* from Malayan soils for determining active root distribution. *Proc. Symp. "Isotopes and Radiation in Soil-plant relationships, including forestry"*. 13-17 Dec. IAEA Vienna p 463-479.

Singh, G., Drew, M. C., Ellis, F. B. and Saker, L. R. (1972). A comparison of different methods for estimating the relative distribution of roots in soil. *Letcombe Laboratory Ann. Rept.* 1972 p 37-38.

#### 4. Mobility of ions in soils

Brendokov, V. F. (1970). Experimental method for studies of the vertical migration of radioisotopes in soil. *Ref. Zh Otd. Vyp. Pochvoved Agrokhim.* 1970. 12:57-182.

Hilal, M. H., Anter, F., El-Damaty, A. H. (1973). A chemical and biological approach towards the definition of calcareous soils. I. Movement and retention of  $P^{32}$  in soils as affected by percentage and particle size of calcium carbonate fraction. *Plant and Soil* 39(3): 496-478.

Ivanov, S. N. and Semenenko, N. N. (1972). Use of  $P^{32}$  to determine mobile phosphates in peat-soils. *Soviet Soil Science* 4 (6): 753-758.

Poelstra, P. and Frissel, M. (1965). Methods used for investigation into the movement of ions in soils by means of radioactive tracers. *Proc. Symp "Use. Isotopes and Radiat. in soil-plant nutrition studies"* - Turkey 1965 IAEA Vienna. p 95-61.

Riekerk, H. (1971). Mobility of phosphorus, potassium and calcium in a forest soil. *Soil Sci. Soc. Amer. Proc.* 35(2): 350-56.

#### 5. Plant nutrition studies

Akhrometko, A. I., Shestakova, V. A. (1958). Investigations of how micro-organisms affect the uptake and release of P and S in Maple, Oak and Ash seedlings. *Mikrobiologiya*. Vol. 27. p 67-74.

Arnold, J. C. (1961).  $P^{32}$  uptake by Pine tree roots. *Georgia Agricultural Research Athens* Vol. 3 (2) p 11.

Bhat, K. K. S. and Nye, P. H. (1973). Diffusion of phosphate to plant roots in soil. I. Quantitative autoradiography of the depletion zone. *Plant and Soil*. 38(1): 161-175.

Biglov, T. T. (1964). Uptake of  $P^{32}$  during low-temperature hardening of winter-grown plants. *Fiziol. Rast.* 11, 480-486.

Bouat, M. (1969). The utilisation of potassium-40 and potassium-42 in agronomy *Ann. Agron.* 20(1): 89-113.

Bowen, G. D. (1969). The uptake of ortho-phosphate and its incorporation into organic phosphates along roots of *Pinus radiata*. *Aust. J. biol. Sci.* 22: 1125-35.

Constantinescu, E. V. and Catrina, I. et al (1970). Studies with radioactive isotopes on the mineral nutrition of *Robina pseudoacacia*. *Studii si Cercetari ale Institutii de Cercetari Silvice* (1970) 27(2): 27-55. *Forestry abstracts* (1972). 33(2): 2512.

- Fardeau, J. C. and de Lille, D. et al (1968). Utilisation de la phytine par les plantes. In "Isotopes and Radiation in soil organic matter studies". IAEA Vienna p 555.
- Fedorosky, D. V. (1972). Radioactive tracer as a means of studying the laws of plant nutrition in heterogenous soil using plants. *Agrochimica* 16(4-5): 300-309.
- Gardner, B. R. and Jones, J. P. (1973). Effects of temperature on phosphate sorption and phosphate desorption. *Comm. Soil Sci. and Plt. Anal.* 4(2): 83-93.
- Harley, C. P. et al (1958). The role of nitrogen in new growth of apple and transport of  $P^{32}$  from roots to leaves during early spring growth. *Proc. Amer. Soc. Hort. Sci.* 72: 57-63.
- Glubrecht, H. (1971). Advances and Problems of isotopic labelling in the investigation of Nutrient interaction. In "Recent Advances in Plant Nutrition. Vol. 2. p. 425 Ed. Samish -R. M., Gordon and Breach.
- Kilian, W. and Lumbe, C. (1972). Different P-uptake of seedlings (*Picea excelsa*, *Pinus sylvestris*, *Alnus glutinosa* and *Secale cereale*). In "Isotopes and Radiation in soil-plant relationships, including forestry". IAEA 1972 p 301.
- Kotelev, V. V. (1956). The importance if the soil microflora for the movement of band-placed phosphorus and its uptake by plants (using a  $P^{32}$  method). *Izv. moldav. fil. Akad. Nauk.* vol.1(21): 9-16. *Soils and Ferts.* 20 No. 268.
- Martin, J. K. (1973). The influence of rhizosphere microflora on the availability of  $^{32}P$ -myo-inositol hexaphosphate phosphorus to wheat. *Soil Biol. Biochem.* 5(4): 473-83.
- McKell, C. M. and Wilson, A. M. (1963). Effects of temperature on  $S^{35}$  uptake and translocation by rose and subterranean clovers. *Agron. J.* 55: 134-137.
- Niemann, E. G., Claussen, W. and Quast, P. (1972). Influence of root-temperature and  $O_2$  supply on the phosphorus uptake of tomato seedlings. In "Isotopes and radiation in soil-plant relationships, including forestry". IAEA p 41.
- Nye, P. H. (1972). Nutrient uptake from soil: our recent studies using isotopes. In "Isotopes and Radiation in soil-plant relationships, including forestry." IAEA (1972). p 3.
- Popa, A. (1964). The use of radioactive isotopes to determine the efficiency of fertilizers-mineral applied to Robina stands on sandy soils. *Rev. Padurilor* Vol. 79(4) p 181-4. *For. Abstr.* 26: 560.
- Tiller, K. G., Honeysett, J. L. and de Vries, M. P. C. (1972). Soil zinc and its uptake by plants. 1. Isotopic exchange equilibria and the application of tracer techniques. *Aust. J. Soil. Res.* 10 p 151-164.

## 6. Use of $Rb^{86}$ as a tracer for potassium

- Deist, J. and Talibudeen, O. (1967). Rubidium-86 as a tracer for exchangeable potassium in soils. *Soil Sci.* 104(2): 119-122.



Hafez, A. and Rains, D. W. (1972). Use of rubidium as a chemical tracer for potassium in long-term experiments in cotton and barley. *Agron. J.* 64(4): 413-417.

Karim, M. Rahman, S. and Raihan, M. (1971).  $Rb^{86}$  as tracer for potassium. I Uptake of Rb and K by rice plant in nutrient solution. *Plant Soil* 35(1): 179-182.

Marschner, H. and Schumansky, C. (1971). Suitability of using rubidium  $^{86}$  as a tracer for potassium in studying potassium uptake by barley plants. *Z. Pflanzenernhr. u. Bodenk.* 128(2): 129-43 *Biol. Abstr.* 52(17): 98061.

Morard, P. and Bur, R. (1972). Comparison de l'utilisation du  $^{86}Rb$  et du  $^{42}K$  comme tracers radioactive pour l'étude de l'absorption du potassium par la sorgho. In "Isotopes and radiation in soil-plant relationships. including forestry". IAEA p. 65.

Smierzchalska, K. (1973). Use of isotopic techniques ( $K-42$ ,  $Kb-86$ ,  $CS-137$ ) in studying the behaviour of potassium in soil. *Rocznika Nauk Polniczych.* A 99(2): 21-38.

#### 7. Mycorrhiza studies

Bowen, G. D. (1968). Phosphate uptake by mycorrhizae and uninfected roots of *Pinus radiata* in relation to root distribution. *Trans. 9th Int. Soil Sci. Congress.* Vol. 2. p 219-228.

Clarkson, D. T. and Sanderson, J. (1972). Accumulation of  $P^{32}$  in the fungal sheath and plant components of beech mycorrhizae. *Letcombe Lab. Ann. Rept.* 1972 p 10-11.

Clode, J. J. E. (1956). The role of mycorrhizae in the translocation of P- a study using  $P^{32}$ . *Publ. Serv. Flor. Agric. Portugal.* 23(2): 167-206. *For. Abstr.* 20: 252.

Gray, L. E. and Gerdemann, J. W. (1973). Uptake of sulphur - 35 by vesicular-arbuscular mycorrhizae. *Plant and Soil.* 39(3): 687-689.

Hattingh, M. J., Gray, L. E. and Gerdemann, J. W. (1973). Uptake and translocation of  $P^{32}$  labelled phosphate to onion roots by endomycorrhizal fungi. *Soil Sci.* 116(5): 383-387.

Hayman, D. S. and Mosse, B. (1972). The role of vesicular-arbuscular mycorrhizae in the removal of phosphorus from soil by plant roots. *Rev. d'Ecol. et Biol. du Sol.* 9: 463-470.

Melin, E. (1957). Transport of  $C^{14}$  labelled photosynthate to the fungal associate of Pine mycorrhiza. *Svensk. bot. Tidskr.* Vol. 51. p 166-186.

Melin, E. and Nilsson, H. (1955).  $Ca^{45}$  used as an indicator of transport of cations to pine seedlings by means of mycorrhizal mycelium. *Sv. Bot. Tidskr.* 49: 119-122.

Mosse, B., Hayman, D. S. and Arnold, D. J. (1973). Plant growth responses to vesicular-arbuscular mycorrhizae V. Phosphate uptake by three plant species from P-deficient soils labelled with  $^{32}P$ . *New Phytol.* 72: 809-815.

Mejstrik, V. (1970). The uptake of  $^{32}P$  by different kinds of ectotrophic mycorrhiza of *Pinus*. *New Phytol.* 69: 295-298.

Reid, C. P. P. and Woods, F. W. (1969). Translocation of  $C^{14}$ -labelled compounds in mycorrhizae and its implications in interplant nutrient cycling. *Ecol.* 50(2): 179-187.

Stribley, D. P. and Read, D. J. (1974). The Ecology of mycorrhiza in the Ericaceae III Movement of  $C^{14}$  from host to fungus. *New Phytol.* 73(4): 731.

Tarabrin, A. D. (1961). Uptake of  $P^{32}$  by mycorrhizal and non mycorrhizal Oak Lesn. *Z. Arhangel'sk Vol.* 4(1): 37-9.

## 8. Techniques for labelling plants

Cornwell, P. B. (1955). Techniques for labelling trees with radioactive P. *Nature, Lond.* 175: 85.

Sauerbeck, D. and Fuhr, F. (1966). Expences on a labelling whole plants with carbon 14. In "The use of radioisotopes in soil organic matter studies" IAEA, p. 391.

Smith, J. H., Allison, F. E. and Mullins, J. F. (1963). A biosynthesis chamber for producing plants labelled with carbon-14. *Atompraxis* 9(3): 73-75.

Zeller, A. and Oberlander, H. E. (1966). A growth chamber for raising Carbon-14 labelled plants. In "The use of radioisotopes in soil organic matter studies". IAEA p. 401.

## 9. Soil micro-organism activity and soil organic matter studies

Aronson, R. B. and Van Slyke, D. D. (1971). Micrometric determination of  $CO_2$  combined with the scintillation counting of  $Cl^{14}$ . *Anal. Biochem.* 41(4): 173-188.

Barber, D. A. (1968). Effects of micro-organisms on the inorganic nutrients by plants. In "Isotopes and Radiation in soil-organic matter studies." IAEA. Vienna. p. 365.

Bartholomew, W. V. and McDonald, I. (1966). Measurement of the organic material deposited in soil during the growth of some crop plants. In "Use of isotopes in soil organic matter studies". Pergamon p. 235.

Broadbent, F. E. (1956). Tracer investigations of plant residue decomposition in soils. U.S. Atomic Energy Comm. T. I. D. - 7512 p. 371-379.

Cheshire, M. V. et al (1969). Transformation of  $^{14}C$  glucose and starch in soil. *Soil Biol. Biochem.* 1: 117-130.

Cheshire, M. V. et al (1968). Transformation of some labelled carbohydrates in soil. *Biochem. J.* 109(2): 1 p

Dawson, P. S. S. and Glättli, (1972). Changing patterns of  $^{32}P$  and  $^{33}P$  utilisation in cells of *candida utilis* during the cell cycle. *Can. J. Microbiol.* 18(11): 1691-1694.

Drobnikova, V. (1963). The application of Radioisotopes in the study of soil metabolism. *Rostlinna, Vyroba.* 34(7-8): 859-862.

Flaig, W. (1966). The future role of isotopes in soil organic matter studies. In "The use of radioisotopes in soil organic matter studies." IAEA p 495.

Freytag, H. E. and Igel, H. (1972). Humification of a  $^{14}C$  - labelled organic matter in soil and the incorporation of  $^{15}N$  humic substances. In "Proceedings of the symposium on soil microbiology." Akademiai Kiado p 167-172.

- Goring, C. A. I. and Clark, F. E. (1952). Radioactive P and the growth and metabolic activities of soil microorganisms. *Proc. Soil Sci. Soc. Amer.* 16: 7-9.
- Grossbard, E. (1971). The utilisation and translocation by micro-organisms of carbon-14 derived from the decomposition of plant residues in soil. *J. Gen. Microbiol.* 66: 339-48.
- Grossbard, E. (1970). An autoradiographic technique for the observation in situ of the progressive decomposition of  $C^{14}$  labelled plant fragments on the surface of the soil. *Biol. Sol.* 12: 23-26.
- Guckert, A. (1968). Contributions to the utilization of radioisotopic techniques for the study of soil organic matter. *Bull. Ecole. Nat. Super. Agron. Nancy* 10(2): 69-100.
- Hubbard, J. S. (1973). Radio-respirometric methods in the measurement of metabolic activities in soil. "Mod. Methods in the study of microbial Ecology". *Bull. Ecole Res. Comm. Sweden.* 17: 199-206.
- Hurst, H. M. and Wagner, G. H. (1969). Decomposition of  $C^{14}$  labelled cell wall and cytoplasmic fractions from hyaline and melanic fungi. *Proc. Soil Sci. Soc. Amer.* 33: 707-11.
- Igel, H. (1969). The humification of  $C^{14}$  labelled glucose and cellulose, with special reference to added mineral elements and level of native humic matter. *Albrecht-Thaer Arch.* 13: 267-282.
- Jenkinson, D. S. (1971). Studies on the decomposition of  $C^{14}$  labelled organic matter in soil. *Soil Sci.* 111(1): 64-70.
- Levin, G. V. (1963). Rapid microbiological determination with radioisotopes. *Adv. Appl. Microbiol.* 5: 95-133.
- Lucas, R. L. (1960). Transport of Phosphorus by fungal mycelium. *Nature* 189: 763.
- Martin, J. K. (1973). The influence of rhizosphere microflora on the availability of  $^{32}P$  myo-inositol hexaphosphate phosphorus to wheat. *Soil Biol. Biochem.* 5: 473-483.
- Martin, J. K. (1971).  $^{14}C$ -Labelled material leached from the rhizosphere of plants supplied with  $^{14}CO_2$ . *Aust. J. Biol. Sci.* 24(6): 1131.
- Mayaudon, J. (1968). Comparative radiorespirometric study of the mineralisation in soil of glucose labelled in the (1), (2), (3-4), (6) and (u) positions. *Ann. Inst. Pasteur. Paris.* 115: 710-730.
- Mayaudon, J. (1968). Stabilisation biologique des protéines  $^{14}C$  dans la sol. In "Isotopes and Radiation in soil organic matter studies." IAEA Vienna 1968 p 177.
- Mayaudon, J. and Simonart, P. (1964). Assimilation of  $P^{32}$ -orthophosphate by soil micro-organisms. *Ann. Inst. Pasteur.* 107 Suppl. No. 3 188-196.
- Monk, C. D. (1971). Leaf decomposition and loss of  $^{45}Ca$  from deciduous and evergreen trees. *Amer. Midl. Nat.* 1971 86(2): 379-84.
- Mutatker, V. K. and Wagner, G. H. (1967). Humification of carbon-14 labelled glucose in soils of Sanborn field. *Proc. Soil. Sci. Soc. Amer.* 31: 66-70.

- Norman, A.G. (1968). The use of isotopes in soil organic matter studies. A survey. In "Organic matter and Soil fertility." p. 89-103. North Holland.
- Nussbaumer, E. et al (1969). A study of the decomposition of radioactive glucose and its effect on structure stability. C. r. hebdomadaire des seances. Acad. Sci. Paris. 269D 1744-47.
- Oberländer, H. E. and Roth, K. (1968). Transformation of  $^{14}\text{C}$  labelled plant material in soils under field conditions. In "Isotopes and Radiation in soil organic matter studies". IAEA p 251.
- Olsen, J. S. and Crossley, D. A. (1961). Tracer Studies of the breakdown of forest litter. Radioecology Proc. 1st Nat. Symp. Radioecology, Colorado. 1961.
- Petty, R. (1963). Loss of rubidium  $^{86}$  and phosphorus  $^{32}$  from forest leaf litter at three seral levels. Proc. Indiana Acad. Sci. 73: 88.
- Reyes, V. G. and Tiedje, J. M. (1973). Metabolism of  $^{14}\text{C}$  uniformly labelled organic material by woodlice (Isopoda: Oniscidea) and soil micro-organisms Soil Biol. Biochem. 5(5): 603-611.
- Shamoot, S., McDonald, L., and Bartholomew, W. V. (1968). Rhizo-decomposition of organic debris in soil. Soil Sci. Soc. Amer. Proc. 32: 817-820.
- Sinha, M. K. (1972). Organic matter transformation in soils. I Humification of  $\text{C}^{14}$  tagged oat roots. Plant and Soil 36(2): 383-293.
- Sinha, M. K. (1972). Organic matter transformations in soil. II Nature of carbohydrates in soils incubated with  $^{14}\text{C}$  labelled oat roots under aerobic and anaerobic conditions. Plant soil 36(2): 295-299.
- Sinha, M. K. (1972). Organic matter transformations in soils IV. Aromatic compounds in fulvic acid of soil incubated with  $\text{C}^{14}$  tagged oat roots under aerobic and anaerobic conditions. Plant and Soil 37(2): 273-281.
- Smith, D. W., Fliermans, C. B. and Brock, T. D. (1973). An isotopic technique for measuring the autotrophic activity of soil micro-organisms in situ. Bull. Ecol. Res. Comm. (Stockholm) 17: 243-246.
- Smith, D. W., Fliermans, C. B. and Brock, T. D. ( ). Technique for measuring  $^{14}\text{CO}_2$  uptake by soil micro-organisms in situ. Appl. Microbiol. 23(3): 595-600.
- Wagner, G. H. (1968). The significance of microbial tissues to soil organic matter. In "Isotopes and radiation in soil organic matter studies." IAEA.
- Witkamp, M. (1968). External factors influencing mineralization and immobilization of some radionuclides from tree litter. In "Isotopes and Radiation in soil organic studies." IAEA p 231.
- Witkamp, M. (1969). Environmental effects on microbial turnover of some mineral elements pt 1: Abiotic factors pt. 11 biotic factors. Soil Biol. Biochem. 1: 167-176 and 177-184.
- Zeller, A., Oberländer, H. E. et al (1966). The humification of carbon- $^{14}$  labelled mycelium in soil. In "The use of isotopes in soil organic matter studies". IAEA p 275.

10. Soil metabolism and chemistry

- Barber, S. A. et al (1972). Characterisation of nutrient supply mechanisms to plant roots using double labelling and the ratio of Ca:Sr absorbed: In "Isotopes and Radiation in soil plant relationships, including forestry." IAEA p 11.
- Blair, G. J. and Crofts, F. C. (1969). A quantitative and radioactive sulphur ( $S^{35}$ ) liquid scintillation method for determining soil and plant sulphur. *Soil Science* 107(4): 277.
- Cho, C. M., Armann, H. (1965). Determination of micro-quantities of several elements in soil solution by isotopic dilution and activation analysis. *Tech. Rep. Ser. int. atom. Energy. Ag.* 48: 125-130.
- Drobnikova, V. (1963). Application of radioisotopes to the study of soil metabolism. *Ust. Ved. Inf. MZLVH (Rostl. Vyroba)* 36: 859-862.
- Freney, J. R., Melville, G. E. and Williams, G. H. (1971). Organic sulphur fractions labelled by addition of  $^{35}S$ -Sulphate to soil. *Soil Biol. Biochem.* 3: 133-41.
- El-Kholi, A. F. Ghattas, N. K. and Hamdy, A. (1972). Estimation of the available manganese in alkaline calcareous soils by the radioisotopes tracer techniques. *Isotope and Radiation Research* 5: 34-50.
- Fried, M. and Broeshart, H. (1967). Determination of soil nutrient supply chap 6. In "The Soil Plant System, (in relation to Inorganic nutrition)." Acad. Press, N.Y. and Lond. 1967.
- Gachon, L. (1972). Fractionating labile phosphorus in relation with the type of soil. *Ann. Agron. (Paris)* 23(4): 429-444.
- Gardner, B. R. and Jones, J. P. (1973). Effects of temperature on phosphate sorption isotherms and phosphate desorption. *Comm. Soil Sci. and Pl. Anal.* 4(2): 83-93.
- Kukura, M., Bell, L. C., Posner, A. M. and Quirk, J. P. (1973). Kinetics of Isotopes Exchange on Hydroxapatite. *Soil Sci. Soc. Amer. Proc.* 37(3): 364-366.
- John, M. K. (1972). Factors affecting the adsorption of micro-amounts of tagged phosphorus by soils. *Comm. Soil. Sci. and Pl. Analysis* 3(3): 197-205.
- Larsen, S. (1968). The influence of soil organic matter on the loss of available phosphate in soil by chemical reactions. In "Isotopes and radiation in soil organic matter studies." IAEA Vienna p 377.
- Lavy, T. L., Messersmith, C. G. and Knoche, H. W. (1972). Direct liquid scintillation radioassay of  $^{14}C$  labelled herbicides in soil. *Weed science* 20(3): 215-219.
- Lopez, Perla, L. and Graham, E. R. (1970). Isotopic exchange studies of micro-nutrients in soils. *Soil Science.* 110(1): 24-30.
- Lopez, P. L. and Graham, E. R. (1972). Labile pool and plant uptake of micro-nutrients. I Determination of labile pool of Mn, Fe, Zn, Co, and Cu in deficient soils by isotopic exchange. *Soil Sci* 114(4): 295-299.
- Lopez, P. L. and Graham, E. R. (1973). Labile pool and plant uptake of micro-nutrients. II Uptake of Mn, Fe, Zn, by ladino clover (*Trifolium repens*) and its relation to soil labile pools. *Soil science* 115(5): 380.

- Martin, J. K. (1970). Organic phosphate compounds in water extracts of soils. *Soil science* 109(6): 362-75
- McLaren, R. G. and Crawford, D. V. (1974). Studies in Soil Copper III Isotopically exchangeable copper in soils. *J. Soil science* 25: 111
- Nafady, M. H. and Lamm, C. G. (1972). Plant nutrient availability in soils IV Studies on the role of copper in Danish soils 3. The exchange properties with particular reference to fixation and release processes. In "Isotopes and radiation in soil-plant relationships, including forestry". IAEA p 181.
- Skujins, J. J. and McLaren, A. D. (1969). Assay of urease activity using  $C^{14}$ -Urea in stored, geologically preserved and in irradiated soils. *Soil Biol. Biochem.* 1: 89-99.
- Talibudeen, O. (1972). Using radiotracers in soil chemistry research. Proc. Symp. "Isotopes and Radiation in Soil-plant relationships including forestry". Dec. 1971 IAEA Vienna p 133-145.
- Tandon, H. L. S. and Kurtz, L. T. (1968). Isotopic exchange characteristics of aluminium and iron-bound fractions of soil phosphorus. *Soil. Sci. Soc. Amer. Proc.* 32(6): 799-802.
- Tiller, K. G. and Wassermann, P. (1972). Radioisotopes techniques and zinc availability in soil. In "Isotopes and Radiation in soil-plant relationships, including forestry." IAEA 1972 p 517.
- Williams, E. G. and Knight, A. H. (1963). Evaluations of soil phosphate status by pot experiments, conventional extraction methods and labile phosphate values *J. Sci. Fd Agric.* 14(8): 555-563.
11. Ecosystem studies
- Calow, P. and Fletcher, C. R. (1972). A new Radiotracer technique involving  $^{14}C$  and  $^{51}Cr$  for estimating the Assimilation of Aquatic, Primary Consumers. *Oecologia* 9: 155-70.
- Clayton, J. L. (1972). Salt spray and mineral cycling in two California coastal ecosystems. *Ecology*. 53(1): 74-81.
- Jordan, C. F. et al. Tritium movement in a tropical ecosystem. *Bioscience* 20(14): 807-812.
- Luse, R. A. (1966). The phosphate cycle in a tropical rain forest (Puerto Rico). Abstr. in *Bull Ecol. Soc. Amer.* 47(3): 120-1.
- Klement, N. W. and Schultz, V. eds: (1965). *Terrestrial and Freshwater Radioecology. A selected bibliography- supp3 TID 3910.* Division of Biology and Med. U.S. Atomic Energy Comm.
- Klement, A. W. and Schultz, V. *Terrestrial and Freshwater Radioecology. A selected bibliography - Supp. 2 TID 3910 U.S. Atomic Energy Comm.*
- Kline, J. R., Stewart, M. L. and Jordan, C. F. (1972). Use of tritiated water for determination of plant transpiration and biomass under field conditions In "Isotopes and radiation in soil plant relationships, including forestry." IAEA p 419.

- McNaughton, D. L. and Wurzel, P. (1971). Tritium in rain as an indicator of air-mass source. *Tellus* 24(3): 255.
- Riekerk, H. and Gessel, S. (1965). Mineral cycling in a Douglas Fir forest stand. *Health Phys.* 11: 1363-69.
- Rigler, F. H. (1956). A tracer study of the phosphorus cycle in lake water. *Ecology*. 37: p 550-62.
- Till, A. R. and May, P. F. (1970). Nutrient cycling in grazed pastures. II Further observations with  $^{35}\text{S}$  sypsum. *Aust. J. Agric. Res.* 21(2): 253
- Ulrich, B. and Mayer, R. (1972). Systems analysis of mineral cycling in forest ecosystems. In "Isotopes and radiation in soil-plant relationships, including forestry". IAEA p 329.
- Ward, F. J. and Nakanishi, M. (1971). A comparison of Geiger-Mueller and liquid scintillation counting methods in estimating primary productivity. *Limnol. Oceanogr.* 16(3): 560-563.
- Woods, F. W. (1970). Interspecific transfer of inorganic materials by root systems of woody plants. *J. Appl. Ecol.* 7(3): 481-86.
- Woods, F. W. and Brock, K. (1964). Interspecific transfer of  $\text{Ca}^{45}$  and  $\text{P}^{32}$  by root systems. *Ecology* 45, 886-9.
- Witkamp, M. (1972). Transfer of  $^{137}\text{Cs}$  from detritus to primary producer. In "Isotopes and radiation in soil plant relationships, including forestry." IAEA p 341.

## 12. Autoradiography and its applications

- Brock, T. D. and Brock, M. L. (1966). Autoradiography as a tool in microbial ecology. *Nature Lond.* 209: 734-36.
- Evans, E. A. (1972). Purity and stability of radiochemical tracers in autoradiography. *J. Microsc. (Oxford)* 96(2): 165-180.
- Evans, T. D. and Syers, J. K. (1972). An application of autoradiography to the study of spectral distribution of  $^{33}\text{P}$  labelled orthophosphate added to soil crumbs. *Soil Sci. Soc. Amer. Proc.* 35(6): 906-909.
- Gahan, P. B. (1972). *Autoradiography for biologists.* Academic Press.
- Held, E. E. (1965). Autoradiography of sectioned soil cores. *Proc Symp on "Radioisotopes and sample measurement techniques in medicine and biology"*. Vienna Int. Atomic. Energy Agency. Vienna p. 553-560.
- Lewis, D. S. and Quirk, J. P. (1967). Phosphate diffusion in soil and uptake by plants. III  $\text{P}^{31}$  Movement and uptake by plants as indicated by  $\text{P}^{32}$  autoradiography. *Plant and Soil* 26: 445.
- Logi, P. and Vanossi, A. (1967). An introduction to quantitative autoradiography European Atomic Energy Community Report EUR 3495 e.
- Otsuka, M., Sakuma, M. and Sato, Y. (1970). Distribution of radioisotopes in whole-body autoradiography. XXIII Effect of Bremstrahlung emission on tritium autoradiography. *Radioisotopes* 19(11): 518-24.
- Preston, K. J. and Waid, J. S. (1972).  $^{14}\text{C}$  Labelled volatiles as a source of errors in autoradiographic studies of fungal mycelia. *Trans Br. mycol Soc.* 59: 151-153.

- Rogers, A. W. (1969). *Techniques of Autoradiography*. Elsevier. 1969.
- Sanderson, J. (1972). Micro-autoradiography of diffusible ions in plant tissue: problems and methods. *J. Microscopy* 96: 245-54.
- Sanderson, J. and Clarkson, D. T. (1972). Quantitative micro-autoradiography of accumulation of phosphorus-32 in tissues from young and mature zones of the barley root. *Letcombe Lab. Ann. Rept.* p 7-10.
- Sawicki, W. Blaton, O. and Rowinski, J. (1971). Correction of autoradiography grain count in respect to precisely calculated background. *Histochemie* 26(1): 67-73.
- Strang, R. H. and Rogers, R. L. (1971). A microradioautographic study of  $^{14}\text{C}$ -trifluralin adsorption. *Weed Science* 19(4): 363-69.
- Toth, S. J. and Romney, E. M. (1954). Comparison of methods for preparing thin tissue plant leaves for autoradiography. *Soil Sci.* 78: 95.
- Waid, J. S. Preston, K. J. and Harris, P. J. (1970). A method to detect metabolically-active micro-organisms in leaf litter habitats. *Soil Biol. Biochem.* 3: 235-41.
- Waid, J. S. Preston, K. J. and Harris, P. J. (1973). Autoradiography techniques to detect active microbial cells in natural habitats. *Bull Ecol. Res. Comm. (Stockholm)* 17: 317-322.
- Weavind, J. E. F. (1969). The relationship between the density of an autordiograph and the concentration of the radioactive substance which produced it. *Agrochemophysica* 1(3/4): 93-96 *Biol. Abstr.* 52(19): 110-399.

### 13. Miscellaneous references

- Bache, B. W. (1970). Barium isotope method for measuring cation exchange capacity of soils and clays. *J. Sci. Agric.* 21(4): 169-171.
- Fraser, D. A. (1958). The translocation of rubidium-86 and calcium-45 in trees. In *"The physiology of Forest Trees"* Ed. K. V. Thimain. Ronald Press. P. 347-363.
- Gold, H. J. (1971). Uniqueness of solutions in linear compartmental tracer analysis (biological processes) *Acta. Biotheor.* 20(3-4) 83-94.
- Hawker, C. D. (1973). Radioimmunoassay and related methods. *Anal. Chem.* 45(11): 878-890.
- Horrocks, D. L. (1973). Radioimmunoassay by liquid scintillation counting. In *"Liquid scintillation counting, Vol. 3"*. Ed. Crook, M. A. and Johnston, P. Heyden.
- Jordan, B. R. A simple radioactivity recording system for column chromatography of  $\text{P}^{32}$  labelled products. *Anal. Biochem.* 30(1): 244-48.
- Leyton, L. (1971). The use of isotopes in tree physiological research. In *"Isotopes and radiation in soil plant relationships, including forestry."* IAEA p 263.
- Liani, A. (1971). The use of radioisotopes in forest research. *Schweiz. Z. Forstw.* 122 (6/7): 268-323 and 312-323.



- Noack, D. (1960). Determination of wood moisture content using radioactive isotopes. 18(8): 304-8.
- Odum, E. P., Martin, R. P. and Loughman, B. C. (1962). Scanning systems for the rapid determination of radioactivity in ecological materials. Ecology. 43(1): 171.
- Robinson, J. R. (1969).  $^{33}\text{P}$  a superior radiotracer for phosphorus? Int. J. Appl. Rad. and Isotopes 20(7): 531-40.
- Rosen, C. G., Erhenberg, L. and Ahnstrom, G. (1964). Tritium labelling of antibodies. Nature, 204: 796-797.
- Strange, R. E. Powell, E. O. and Pearce, T. W. (1971). The rapid detection and determination of sparse bacterial populations with radioactivity labelled homologous antibodies. J. Gen. Microbiol. 67: 349-57.
- Thorburn, C. C. (1972). Isotopes and radiation in biology. Halstead Press/ John Wiley New York.
- Veglia, A. and Keckes, S. (1971). Simultaneous application of radionuclides in tracer experiments. Int. J. Appl. Rad. Isot. 22(9): 549-559.
- Wetteran, L. W. and Huebotter, R. J. (1970). Rapid urine assay for tritium. Health Phys. 19(3): 449.